

**Amendment and Response**

Applicant: Hong-Jyh Li, et al.

Serial No.: 10/799,910

Filed: March 12, 2004

Docket No.: I550.115.101/2004P50029US

Title: ION IMPLANTATION OF HIGH-K MATERIALS IN SEMICONDUCTOR DEVICES

**IN THE CLAIMS**

Please amend claims 1 and 15 as follows:

1. (Currently Amended) A semiconductor device comprising:  
a substrate including isolation regions and active regions;  
a high-k material layer ~~implanted with~~ including an ionized species, the high-k material layer proximate the substrate;  
a gate electrode proximate the high-k material layer; and  
a conductive buffer layer ~~implanted with~~ including an ionized species, the conductive buffer layer being disposed between the high-k material layer and the gate electrode.
2. (Original) The semiconductor device of claim 1, wherein a transistor is formed from the substrate, the high-k material layer, and the gate electrode.
3. (Original) The semiconductor device of claim 1, further comprising:  
a pre-gate material layer between the substrate and the high-k material layer.
4. (Original) The semiconductor device of claim 3, wherein the pre-gate material layer comprises one of SiO<sub>2</sub> and SiON.
5. (Original) The semiconductor device of claim 3, wherein the pre-gate material layer has a thickness within the range of 2Å to 10Å.
6. (Cancelled)
7. (Previously Presented) The semiconductor device of claim 1, wherein the buffer layer comprises one of TiN, HfN, TaN, ZrN, LaN, and TiSi.

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8. (Previously Presented) The semiconductor device of claim 1, wherein the buffer layer has a thickness within the range of  $10\text{\AA}$  to  $200\text{\AA}$ .
9. (Original) The semiconductor device of claim 1, wherein the species comprises one of N, F, Si, O, Hf, Zr, Ti, Ta, Y, V, Sc, Ba, Sr, Ru, B, Al, Ga, In, Ge, C, P, As, and Sb.
10. (Original) The semiconductor device of claim 1, wherein the high-k material layer comprises one of  $\text{HfO}_2$ ,  $\text{HfSiO}_x$ ,  $\text{ZrO}_2$ ,  $\text{ZrSiO}_x$ ,  $\text{SiO}_2$ ,  $\text{SiON}$ ,  $\text{Ta}_2\text{O}_5$ ,  $\text{La}_2\text{O}_3$ , and  $\text{Al}_2\text{O}_3$ .
11. (Original) The semiconductor device of claim 1, wherein the high-k material layer has a thickness within the range of  $10\text{\AA}$  to  $60\text{\AA}$ .
12. (Original) The semiconductor device of claim 1, wherein the high-k material layer has an equivalent oxide thickness within the range of  $3\text{\AA}$  to  $20\text{\AA}$ .
13. (Original) The semiconductor device of claim 1, wherein a dose of the implanted species is within the range of  $1 \times 10^{13}$  ions/ $\text{cm}^2$  to  $1 \times 10^{16}$  ions/ $\text{cm}^2$ .
14. (Original) The semiconductor device of claim 1, wherein the isolation regions comprise trench isolation regions.
15. (Currently Amended) A transistor comprising:  
a gate electrode;  
a high-k gate dielectric layer ~~implanted with~~ including an ionized species, the high-k gate dielectric layer proximate the gate electrode;  
a substrate comprising an active region, the substrate proximate the high-k gate dielectric layer; and  
a conductive buffer layer ~~implanted with~~ including an ionized species, the conductive buffer layer being disposed between the gate electrode and the high-k gate dielectric layer.

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16. (Cancelled)

17. (Original) The transistor of claim 15, wherein the gate electrode comprises one of aluminum and polysilicon.

18-40. (Cancelled)